Transforaminal and Posterior Lumbar Interbody Fusion for Llumbar Degenerative Diseases, which one is better: A meta-analysis Through a Ggrade Analysis of Evidence

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Research article

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Abstract

Background

To explore the efficacy and safety between posterior lumbar interbody fusion (PLIF) and transforaminal lumbar interbody fusion (TLIF) in the treatment of lumbar degenerative diseases.

Methods

We searched the literature in Pubmed, Embase, Cochrane Library and Web of Science. The index words were posterior lumbar interbody fusion, PLIF, transforaminal lumbar interbody fusion, TLIF, lumbar interbody fusion, spinal fusion, degenerative disc disease and lumbar degenerative diseases. Primary outcomes were fusion rate and complications. Secondary outcomes were visual analog scale (ΔVAS), Oswestry Disability Index (ΔODI), total blood loss, operation time and length of hospital stay. Review Manager 5.3 and Stata13.1 was used for the analysis of forest plots, heterogeneity, sensitivity and publication bias.

Results

17 studies were included (N=1562; PLIF, n=835; TLIF, n=727). The pooled data showed PLIF had a higher complications (P= 0.000), especially in nerve injury (p = 0.003) and dural tear (p = 0.005). PLIF required longer operation time (p = 0.004), more blood loss (p = 0.000) and hospital stays (p = 0.006). Surprisingly subgroup analysis showed there was significant difference in complications in patients under 55 (p = 0.000) and Asian countries (p = 0.000). No statistical difference was found between the two groups with regard to fusion rate (p = 0.593),ΔVAS (p = 0.364) andΔODI (p = 0.237).

Conclusions

This meta-analysis showed there were no significant difference in fusion rate, ΔVAS and ΔODI. However TLIF could reduce complications, especially nerve injury and dural tear. Besides, TLIF was associated with statistically significant less blood loss, shorter operation time and shorter length of hospital stay.

Background

Lumbar interbody fusion (LIF) is an established treatment for a range of spinal disorders including; degenerative pathologies, trauma, infection and neoplasia[1]. The procedure has been first described independently by Albee and Hibbs in 1911[2-3]. In 1944, Shinners and Hamby reported patients with disc protrusions could be treated by removal of the protruded disc and spine fusion[4]. In 1953 Cloward improved the traditional spine fusion by bone grafting and reported posterior lumbar interbody fusion (PLIF) [5]. This procedure can fully decompress the nerve and enable a stable three-column fixation with 360° fusion and anterior support. The deficiency is the extensive dissection of the paravertebral soft tissue and a large incision. Lin improved this surgery preserving the integrity of facets in the 1970s[6]. Harms and Rolinge reported transforaminal lumbar interbody fusion (TLIF) in 1982[7]. Nerve decompression, bone graft and spine fusion were performed by unilateral approach in TLIF，which could reduce surgical trauma. This procedure can preserve the posterior bony and soft tissue structures as much as possible. Its indications include all degenerative pathologies, such as broad-based disc prolapses, degenerate disc disease, recurrent disc herniation, pseudoarthrosis, and symptomatic spondylosis. Contraindications are similar to PLIF, including extensive epidural scaring, arachnoiditis, active infection and conjoined nerve roots (that may preclude access to the disc space) and osteoporotic patients.

Multiple studies have attempted to compare PLIF versus TLIF in terms of clinical and fusion outcomes. However, there is no consistent and definitive evidence for which one approach being superior to another. As a surgical procedure with a gentle learning curve, PLIF is more extensive than TLIF. The more lateral exposure to the interspace in TLIF as compared to PLIF gives it three distinct advantages over the latter, which are lesser neural retraction, a unilateral procedure and making revision surgeries less challenging[8]. It is still a question whether TLIF could be able to replace PLIF in lumbar operations.

Previous meta-analysis has some disadvantages, especially in the choice of statistical effect size and the subgroup division. We performed a systematic review of the literature and a meta-analysis on the effectiveness of both procedures in fusion rate, postoperative complications and other clinical outcomes in patients with LIF.

The innovation of this research lies in the followings. First, we used GRADE system to evaluate the clinical outcomes, making the conclusions more objective. Second, the subgroup analysis conducted some interesting results. There was statistically different in complications according to the age and countries, which were a totally new discovery.

Materials And Methods

Search strategy

The way to retrieve relevant studies is to use posterior lumbar interbody fusion, PLIF, transforaminal lumbar interbody fusion, TLIF, lumbar interbody fusion, spinal fusion, degenerative disc disease and lumbar degenerative diseases as key words with Boolean operators AND or OR in electronic databases including PubMed, Embase, Cochrane Library and Web of Science up to Feb 2020. The language of the literature was limited to Chinese and English. Two reviewers independently extracted relevant information from each eligible study. If there was disagreement, a third author was asked to join the discussion to resolve the controversy.

Inclusion criteria

Trials were included on condition that they met the PICOS (population, intervention, comparator, outcome, study design) criteria.

Population: patients underwent PLIF or TLIF for lumbar degenerative diseases

Intervention: transforaminal lumbar interbody fusion

Comparator: posterior lumbar interbody fusion

Outcomes: The primary outcomes are fusion rate and complications, such as screw broken or loose, cage migration, infection, dural tear and neural injury. The secondary outcomes contained the changes of the following: visual analog scale (VAS)、Oswestry Disability Index (ODI)、total blood loss、operation time、length of hospital stay

Study design: RCT and retrospective study

Data extraction

A standard data extraction form was used to collect the relevant data from included studies. Two reviewers collected available data from included studies independently, and any disagreement between the two reviewers was judged by a third reviewer. The relevant data included authors, published dates, intervention types, age, sample size, clinical diagnosis, duration of follow-up and reference type. Data on outcomes were obtained or statistics estimated from the data presented in tables or figures if no direct data were available from the article text.

Methodological evaluation and quality assessment

We used Cochrane Handbook to assess the quality of RCT and the Newcastle–Ottawa scale (NOS) to accomplish the methodological evaluation of non-RCTs[9-10]. According to the Cochrane Handbook for Systematic Reviews of Interventions, the methodological quality and basis of RCT were assessed as follows: randomization, allocation concealment, blind method, selective reporting, incomplete outcome data, and other bias. The NOS scale consists of eight items, categorized into three dimensions with a total of 9 points: selection of the study population (4 points), comparability between groups (2 points) and measurement of exposure factors (3 points). In general, if the total score of a single study reached or exceeded 6 points, it was considered a high-quality study; otherwise, it was a low-quality study. We used GRADE system to evaluate the level of the evidence and strength of recommendations for included outcomes[11]. Initially, RCTs were considered as high confidence in an estimate of effect and cohort studies were considered as low confidence. Reasons that may decrease the level of confidence include limitations, inconsistency, indirectness, and imprecision, and publication bias. Reasons that may raise the level of confidence include large effect, plausible confounding, dose-response. The GRADE evidence was divided into the following categories: (1) High-quality evidence, which indicated that further research was unlikely to change the confidence in an estimate of effect; (2) Moderate-quality evidence, which indicated that further research was likely to have an important impact on confidence in an estimate of effect and may change the estimate; (3) Low-quality evidence, which indicated that further research was likely to have an important impact on confidence in an estimate of effect and was likely to change the estimate; and (4) Very low-equality evidence, which indicated that we were very uncertain about the results.

Statistical analysis and data synthesis

Meta-analyses were performed with Review Manager Software for Windows (Version 5.3. Copenhagen: The Nordic Cochrane Centre, the Cochrane Collaboration, 2014) and Stata (Version 13.1). The standard mean difference (SMD) was used to assess continuous outcomes with a 95% confidence interval (CI). Odds ratio (OR) with a 95% CI were used to assess dichotomous outcomes. The inverse variance method was used to combine separate statistics. If P values were less than 0.05, the results were considered statistically significant.

Investigation of heterogeneity and publication bias

Statistical heterogeneity of the included studies was evaluated using the chi-square test in accordance with the values of P and I^2. If the values of I^2 < 50%, the heterogeneity might not be important. A fixed-effects model was used to assess these outcomes. If I^2 was between 50% and 100%, it could represent substantial heterogeneity. We used random-effects model to evaluate these outcomes. Thresholds for the interpretation of I^2 can be misleading, since the importance of inconsistency depends on several factors. Therefore, subgroup analysis or sensitivity analysis was performed to interpret the potential source of heterogeneity. Stata13.1 was used to evaluate the publication bias.

Results

Study inclusion and baseline characteristics

Finally, 17 studies were included in our meta-analysis[12-28]. One was RCT[15]; one was prospective cohort study[12]; others were retrospective studies. The Flow chart of the trial selection process was presented in Fig.1. Baseline characteristics of included trials are presented in Table 1.

Risk of bias

The results of Newcastle-Ottawa scale and GRADE analysis are presented in Table 1 and Table 2. The only RCT did not mention how the allocation concealment and blind method were used, so it was high risk[15].

Primary outcomes

Fusion rate. 17 studies reported fusion rate (N=987; PLIF, n=515; TLIF, n=472). The pooling data showed there was no significant difference between both groups (OR=0.832, 95%CI [0.423, 1.636], P=0.593, Fig.2a)

Complications. 17 studies reported complications (N=1562; PLIF, n=835; TLIF, n=727). A pooled odds ratio for complications was 2.290 (95%CI [1.543, 3.399], P=0.000, Fig.2b), indicating a significantly lower complication rate in TLIF, especially in nerve injury (OR=2.704, 95%CI [1.405, 5.204], P= 0.003, Fig.3a) and dural tear (OR=2.213, 95%CI [1.276, 3.841], P= 0.005, Fig.3b). There were no significant difference in other complications reported, such as screw broken or loose (OR=1.146, 95%CI [0.444, 2.955], P= 0.778, Fig.3c), wound infection (OR=1.489, 95%CI [0.760, 2.917], P= 0.246, Fig.3d) and cage migration (OR=2.177, 95%CI [0.442, 10.732], P= 0.339, Fig.3e). Subgroup analysis showed there was significant difference in complications for patients under 55 (OR=2.736, 95%CI [1.775, 4.217], P= 0.000, Fig.4a) and for Asian countries (OR=2.385, 95%CI [1.596, 3.564], P= 0.000, Fig.4b).

Secondary outcomes

ΔVAS. The improvement of VAS was reported in 8 studies (N=806; PLIF, n=414; TLIF, n=392). SMD was 0.064 (95%CI [-0.075, 0.203], P= 0.364, Fig.5a).

ΔODI. The improvement of ODI was reported in 5 studies (N=353; PLIF, n=174; TLIF, n=179). SMD was 0.126 (95%CI [-0.083, 0.336], P= 0.237, Fig.5b).

Total blood loss. The total blood loss was reported in 9 studies (N=693; PLIF, n=362; TLIF, n=331). SMD was 0.796 (95%CI [0.376, 1.217], P= 0.000, Fig.5c).

Operation time. The Operation time was reported in 9 studies (N=702; PLIF, n=385; TLIF, n=317). SMD was 0.618 (95%CI [0.202, 1.033], P= 0.004, Fig.5d).

Length of hospital stay. The Length of hospital stay was reported in 8 studies (N=693; PLIF, n=401; TLIF, n=292). SMD was 0.340 (95%CI [0.099, 0.581], P= 0.006, Fig.5e).

Sensitivity analysis and publication bias

We performed the sensitivity analysis by the method of “trim and fill method” through packages of metatrim in Stata 13.1. We tested the publication bias of dichotomous variable with harbord, and continuous variable with egger by Stata 13.1.

Sensitivity analysis showed that the 95% confidence interval (95% CI) was no statistical difference in each outcome after “trim and fill method”, indicating the pooled datas were steady. By harbord or egger test, if P Value was less than 0.05, there was publication bias. Table 3 was the detailed results of sensitivity analysis and publication bias.

Discussion

Lumbar fusion is an accepted and effective technique for the treatment of lumbar degenerative disease[29]. Advancements in technique continue through the present day. PLIF is a original LIF approach, which involves the insertion of two cages through a bilateral approach. PLIF is considered as a standard surgical technique for lumbar degenerative diseases. However, the inevitable retraction of the thecal sac increases the risks of dural tear and nerve root injury. And excessive intraoperative dissection and retraction of the paraspinal musculature can lead to muscular injury, denervation and atrophy, and consequent chronic pain and weakness[30]. TLIF is a modification of PLIF, which can achieve interbody fusion with the insertion of cages only by the unilateral approach with less dural retraction. So TLIF is invasive than traditional PLIF. In this meta-analysis, we compared the common clinical outcomes between the PLIF and TLIF in patients undergoing lumbar interbody fusion, including fusion rate, complications, the improvement of VAS and ODI, blood loss, operation time, and the length of hospital stay.

The outcome was similar in fusion rate and improvement of VAS and ODI, indicating there is no significant difference in the primary goal of solid fusion and improvement of symptoms. The two approaches are effective.

Overall, TLIF performed better than the PLIF in complication prevention, especially in nerve injury and dural tear. According to age, subgroup analysis showed there was statistical difference in patients under 55 regarding to complications between the two operations, not in patients over 55. A possible explanation for this might be that surgeons were more cautious about operating on older patients to reduce the risk of serious complications. According to nationality, subgroup analysis showed the PLIF complications are higher in Asia, however there was no significant difference in the complications between the two operations in the Occident. The disparity can be due to the differing experience of the operating surgeons with the technique. Surgeons might be more proficient and medical environment is better in the Occident.

With an ageing population, lumbar degenerative diseases often occur in the elderly underlying other diseases. Facing such a group with poor surgical tolerance, prone to intraoperative and postoperative complications and nosocomial infections, It is of great significance to reduce surgical trauma, shorten surgical time and reduce hospital stay. This study found that TLIF was exactly superior to PLIF in just above aspects. The dura sac and nerve root obstruct the approach to the disk space when PLIF is performed bilaterally, so the surgeon must perform the discectomy and cage insertion in a bilateral fashion, increasing the operative time and blood loss. In contrast, TLIF is performed in a unilateral approach to the disk space with a single cage, thus reducing operative time and blood loss[15].

Minimal access surgery has revolutionized most surgical disciplines and spine surgery is no exception. Minimally invasive transforaminal lumbar interbody fusion (MI-TLIF) was devised to reduce the approach-related morbidity of open TLIF and has flourished in the last decade[31]. It can significantly reduce blood loss[32]. However, there is a lack of multi-centre RCTs directly comparing open TLIF with MI-TLIF.

There were some limitations in this meta-analysis. We initially planned to produce a review with only prospective studies. However, exploration of the literature indicated a limited availability of prospective studies. The included literature were mainly retrospective, only two prospective studies. Though the NOS scores of included studies were high quality , the GRADE evidence showed that evidence level is not very satisfying，most were moderate quality and low quality， indicating that the follow-up research might affect the current conclusion. And the sample size is relatively small. So the pooling outcomes might be biased.

Conclusions

This meta-analysis showed there were no significant difference in fusion and the improvement of VAS and ODI. However TLIF could reduce complications, especially the nerve injury and dural tear. On the other hand, TLIF performed better in reducing intraoperative bleeding, shortening operative time and hospital stay. So TLIF might be a preferred choice for the older undergoing basic diseases. Considering the shortcomings of this study, more long-term follow-up RCTs and large sample are expected to provide further evidence of efficacy and safety between PLIF and TLIF in the treatment of lumbar degenerative diseases.

Abbreviations

posterior lumbar interbody fusion (PLIF); transforaminal lumbar interbody fusion (TLIF); population, intervention, comparator, outcome, study design (PICOS); visual analog scale (ΔVAS); Oswestry Disability Index (ΔODI); Minimally invasive transforaminal lumbar interbody fusion (MI-TLIF); standard mean difference (SMD); confidence interval (CI);Odds ratio (OR)

Declarations

Ethics approval and consent to participate

Not applicable

Consent for publication

Written informed consent was obtained from all patients for data

publication, including images

Availability of data and materials

All data generated or analysed during this study are included in this

published article

Competing interests

The authors declare that they have no competing interests in this section.

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Declaration of Authors' contributions

AT and J M designed research, performed research ,and wrote the paper ,X M was a major contributor in writing the manuscript and analyzed data, All authors read and approved the final manuscript.

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None

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Tables

Table 1 Characteristics of included studies

Study (year)	Number of patients(n)		Gender(M/F)		Age (years, M±SD)		Follow-up (months)		Country	Diagnosis	Reference type	NOS
	PLIF	TLIF	PLIF	TLIF	PLIF	TLIF	PLIF	TLIF				
Al 2015	40	50	12/28	19/31	51.6	49.5	60	60	Jordan	Degenerative disc disease	Retrospective	8
Asil 2016	41	33	12/29	8/25	55.76±7.78	53.76±7.95	12	12	Turkey	Degenerative narrow spinal canal and lumbar spondylolisthesis	Retrospective	8
Audat 2012	27	37	6/21	14/23	50.6±13.1	45.8±12.3	36	36	Jordan	Degenerative disc disease	Retrospective	8
Cheng 2017	40	43	19/21	18/25	58.5±8.1	59.7±8.4	24	24	China	Degenerative lumbar spondylolisthesis	prospective cohort	8
de Kunder 2016	48	48	23/25	17/31	58	58	12	12	Netherlands	Spondylolisthesis (isthmic or degenerative)	Retrospective	8
Fariborz 2016	30	30	18/12	15/15	30-40	30-40	12	12	Iran	Disk herniation or lumbar canal stenosis	Retrospective	8
Han 2016	26	36	16/10	20/16	57.31±9.04	59.69±8	19	21	China	Lumbar spondylolisthesis	Retrospective	8
Humphreys 2001	34	40	22/12	20/20	40	41	13	13	USA	Degenerative disc disease, central disc herniation and spondylolisthesis	Retrospective	8
Lee 2017	30	21	7/23	5/16	56.5±13.1	59.4±13.0	19	23	Korea	Degenerative spinal stenosis and spondylolytic spondylolisthesis	Retrospective	8
Li 2016	26	25	17/9	18/7	43.8±12.1	44.5±12.4	43	43	China	Recurrent lumbar disc herniation	Retrospective	8
Liu 2016	125	101	40/85	42/59	55.1±10.2	54.1±12.9	NG	NG	China	Degenerative lumbar spondylolisthesis	Retrospective	8
Mehta 2011	76	43	34/42	16/27	48.6±12.3	48.1±14.6	24	24	USA	Degenerative disc disease and spondylolithesis	Retrospective	8
Park 2005	99	29	43/56	10/19	54	57	20.2	10.4	Korea	Spinal stenosis and instability	Retrospective	8
Sakeb 2013	52	50	11/41	14/36	46±5.9	49±6.9	12	12	Bangladesh	Lumbar instability	Retrospective	8
Yan 2008	85	91	41/44	46/45	58.7±9.6	57.5±11.2	29.5	29.6	China	Degenerative spondylolisthesis	Retrospective	8
Yang 2016	34	32	14/20	13/19	42.7	44.1	30.5	30.5	China	Isthmic spondylolisthesis	RCT	8
Zhuo 2009	22	18	14/8	13/5	41	43	63	73	China	Recurrent lumbar disc protrusio	Retrospective	8

Table 2 The GRADE evidence quality for each outcome

Outcomes	Design	Decrease quality of evidence					Increase quality of evidence			Quality
		Limitations	Inconsistency	Indirectness	Imprecision	Publication bias	Large effect	Plausible confounding	Does-response	
Fusion rate	observational studies	no	no	no	no	unlikely	no	no	no	⊕⊕⊖⊖ Low
Complications	observational studies	no	no	no	no	likely	large	no	no	⊕⊕⊖⊖ Low
Nerve injury	observational studies	no	no	no	no	likely	large	no	no	⊕⊕⊖⊖ Low
Screws	observational studies	no	no	no	no	unlikely	no	no	no	⊕⊕⊖⊖ Low
Infection	observational studies	no	no	no	no	likely	no	no	no	⊕⊖⊖⊖ Very L
Cage migration	observational studies	no	no	no	no	unlikely	large	no	no	⊕⊕⊕⊖ moder
Drual tear	observational studies	no	no	no	no	unlikely	large	no	no	⊕⊕⊕⊖ moder
Revision	observational studies	no	no	no	no	unlikely	no	no	no	⊕⊕⊖⊖ Low
ΔVAS	observational studies	no	no	no	no	unlikely	no	no	no	⊕⊕⊖⊖ low
ΔODI	observational studies	no	no	no	no	unlikely	no	no	no	⊕⊕⊖⊖ low
Total blood loss	observational studies	no	no	no	no	unlikely	large	no	no	⊕⊕⊕⊖ moder
Operation time	observational studies	no	no	no	no	unlikely	large	no	no	⊕⊕⊕⊖ moder
Length of hospital stay	observational studies	no	no	no	no	unlikely	large	no	no	⊕⊕⊕⊖ moder

High quality: Further research is very unlikely to change our confidence in the estimate of effect.
Moderate quality: Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.
Low quality: Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.
Very low quality: We are very uncertain about the estimate.

Table 3 Sensitivity analysis and publication bias

Stability test	Fusion rate	Complications	Nerve injury	Screw broken or loose	Wound infection	Cage migration	Dural tear	ΔVAS	ΔODI
95% CI Before metatrim	(0.423,1.636)	(1.543,3.399)	(1.405,5.204)	(0.444,2.955)	(0.760,2.917)	(0.442,10.73)	(1.276,3.841)	(-0.075,0.203)	(-0.083,
95% CI After metatrim	(0.423,1.636)	(1.366,3.124)	(1.405,5.204)	(0.444,2.955)	(0.672,2.375)	(0.442,10.73)	(1.194,3.623)	(-0.075,0.203)	(-0.083,
Published bais (P Value)	0.560	0.001	0.007	0.055	0.001	0.094	0.120	0.425	0.742

Figures

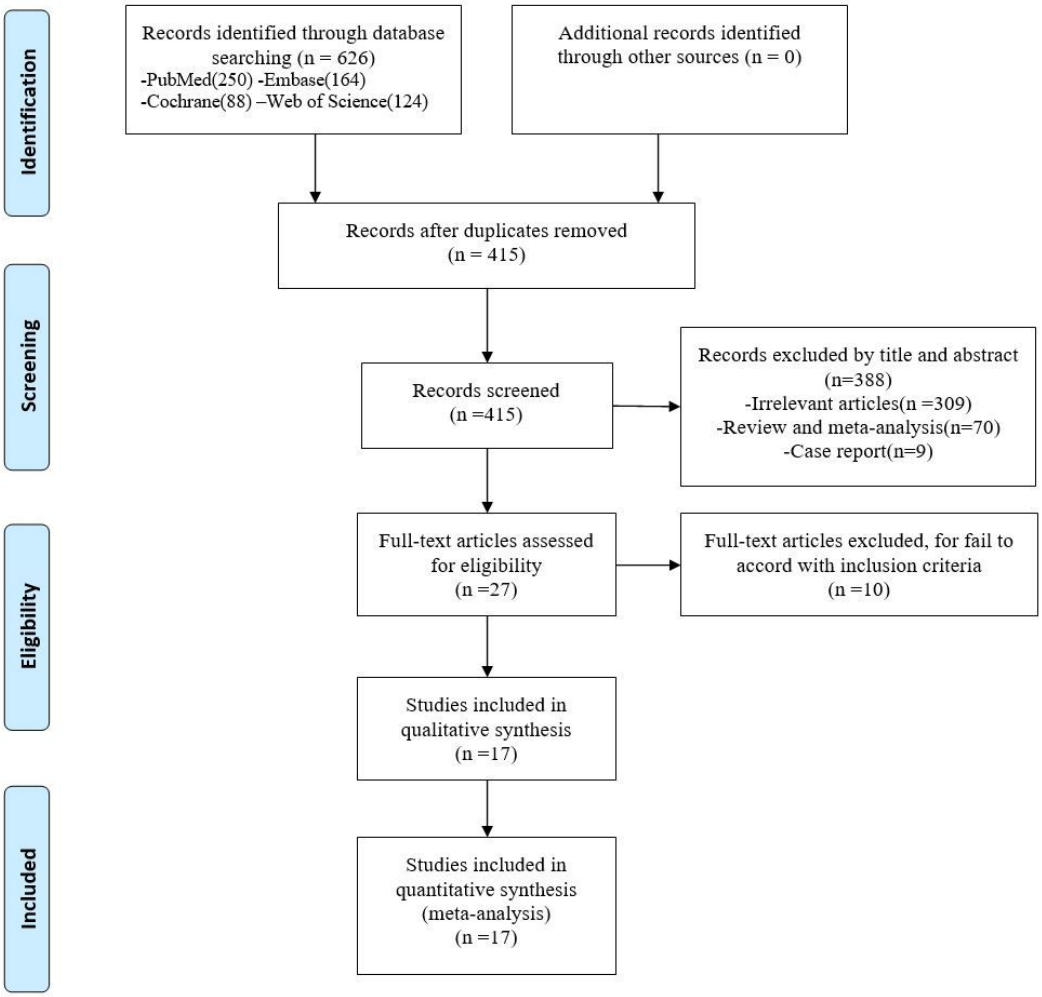

Figure 1

The Flow chart of the trial selection process was presented

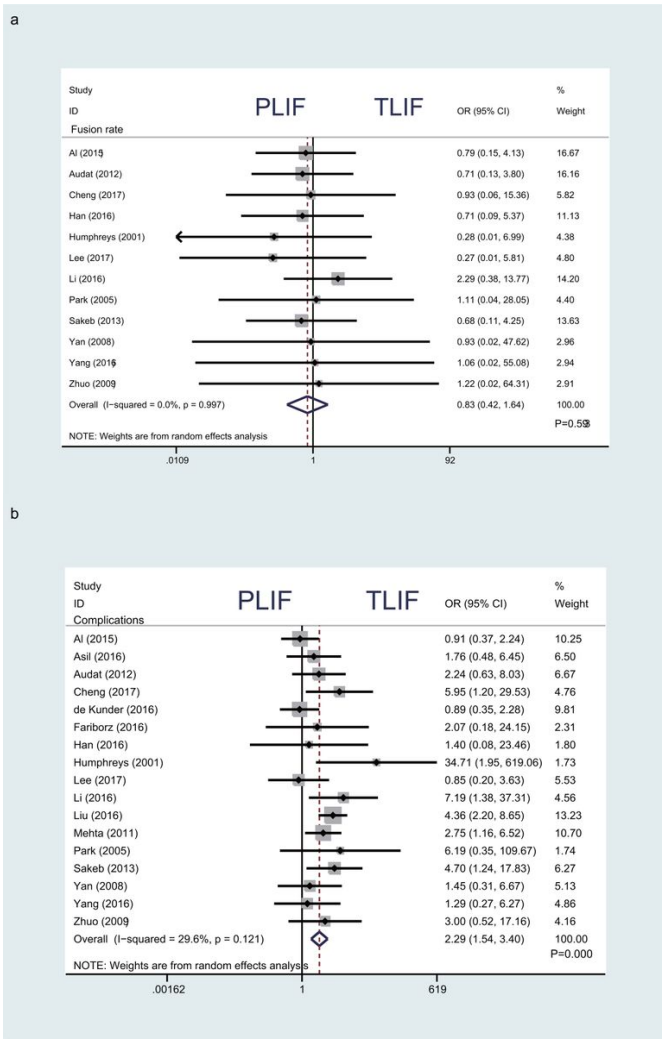

Figure 2

studies reported fusion rate (N=987; PLIF, n=515; TLIF, n=472). The pooling data showed there was no significant difference between both groups (OR=0.832, 95%CI [0.423, 1.636], P=0.593,)

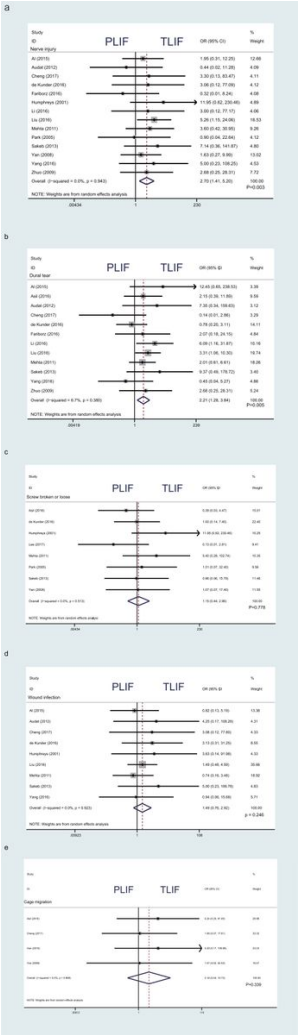

Figure 3

studies reported complications (N=1562; PLIF, n=835; TLIF, n=727). A pooled odds ratio for complications was 2.290 (95%CI [1.543, 3.399], P=0.000, Fig.2b), indicating a significantly lower complication rate in TLIF, especially in nerve injury (OR=2.704, 95%CI [1.405, 5.204], P= 0.003,) and dural tear (OR=2.213, 95%CI [1.276, 3.841], P= 0.005,).

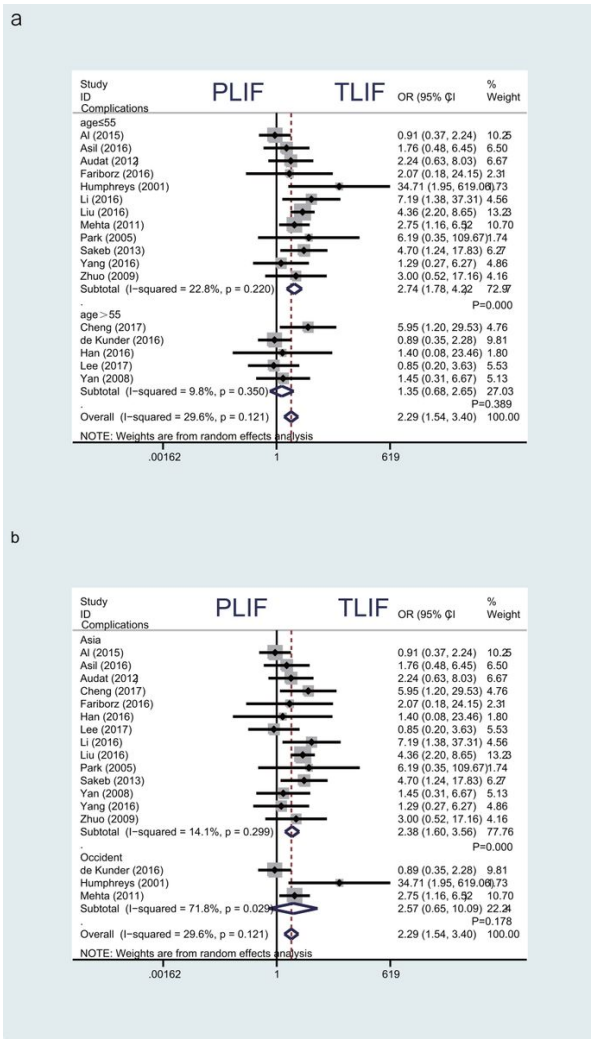

Figure 4

Subgroup analysis showed there was significant difference in complications for patients under 55 (OR=2.736, 95%CI [1.775, 4.217], P= 0.000,) and for Asian countries (OR=2.385, 95%CI [1.596, 3.564], P= 0.000,).

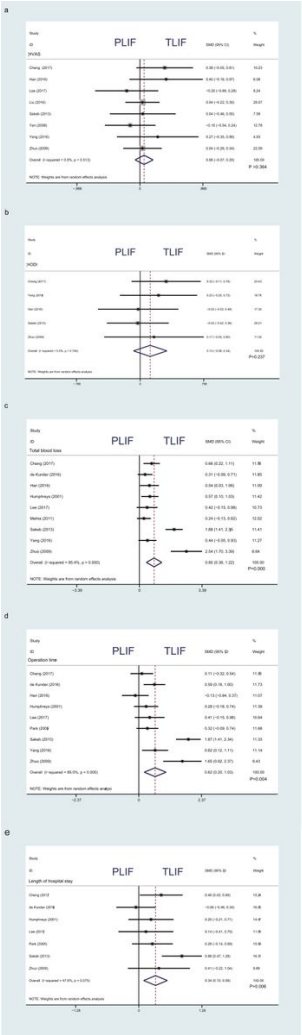

Figure 5

ΔVAS. The improvement of VAS was reported in 8 studies (N=806; PLIF, n=414; TLIF, n=392). SMD was 0.064 (95%CI [-0.075, 0.203], P= 0.364,).